RAPTOR RESEARCH

Volume 17

Number 4

Winter 1983

Raptor Research Foundation, Inc.
Provo, Utah, U.S.A.

RAPTOR RESEARCH **Winter 1983**

Volume 17, Number 4, Pages 97-128

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RAPTOR RESEARCH

Published Quarterly by the Raptor Research Foundation, Inc.

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NEST TREE, HABITAT SELECTION AND PRODUCTIVITY OF SEVEN NORTH AMERICAN RAPTOR SPECIES BASED ON THE CORNELL UNIVERSITY NEST RECORD CARD PROGRAM

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Abstract

Nesting habitat and egg and nesting productivity are summarized from the North American Nest Record Card Program (Cornell University) for seven raptors of the Ottawa National Forest, Michigan. Summaries for the midwestern United States and the North American continent for the Barred Owl, the North American Accipiters, the Red-shouldered Hawk, Northern Harrier and the Merlin used all available data from the initiation of the card program through the fall of 1978.

Introduction

Presented here is a select subset of literature review on the management opportunities for seven raptor species of the Ottawa National Forest, Michigan. We present data summaries on nest tree, nesting habitat selection, and egg and nestling productivities for the Barred Owl (*Strix varia*), the three North American accipiters (*Accipiter gentilis, A. cooperii,* and *A. striatus*), the Red-shouldered Hawk (*Buteo lineatus*), Northern Harrier (*Circus cyaneus*), and the Merlin (*Falco columbarius*). Data in this paper are strictly from the Cornell University North American Nest Record Card Program. We were attracted to this data base because literatures revealed a void of the data necessary for understanding raptors of the Ottawa National Forest study area and sufficient for assessing the effects of land management practices on these species.

Methods

Information on nesting habitat selection and productivity of each raptor species was summarized from nest record card files, Cornell Laboratory of Ornithology. The entire data base for each species, from the inception of the card file to October, 1978, is summarized in this paper. Raptor productivity for purposes of this investigation was defined as any measure of reproductive potential including number of eggs, nestlings, or fledglings.

Because cards were mostly filed by amateur ornithologists and lay persons, a disparity of information existed as shown by differences in sample sizes among the parameters. We used card information strictly as presented, including use of plant common names, and nesting habitat types. We have purposely not added our interpretational biases by trying to define what we believe habitat types are like. We refer readers to Gleason (1952) Vines (1976) and Hitchcock and Cronquist (1978) for taxonomic nomenclature for tree species listed in this document.

TABLE 1

Tree Species and Species Groups
Used by Nesting Barred Owls

	North America		Midwest	
	Total #	% of Total	Total #	% of Total
DECIDUOUS:				
Elm	7	21	4	21
Hickory	2		2	
Aspen	1		1	
Beech	5	15	3	18
Sycamore	1		1	
Maple	5	15	3	18
Yellow Birch	1		1	
Oak	2		2	
Sweetgum	3			
Subtotal:	29	88	17	100
CONIFEROUS:				
Cypress	4	12	0	0
Subtotal:	4	12	0	0
TOTALS:	33	100	17	100

To lend relevance to our investigations of these species in the Ottawa National Forest, data were summarized into midwestern and North American geographical levels. Midwestern states included: Michigan, Minnesota, Wisconsin, Illinois, Indiana, Ohio, and Pennsylvania.

Results

Barred Owl

Nest Tree and Habitat Selection

Of the 10 tree species or species groups used by nesting Barred Owls in North America, the same 3 were preferred over North America and in the midwest (Table 1). Over North America, elm was used most frequently followed by beech. Midwestern conifers apparently were not used. Data show cypress was the only conifer used. Unidentified oaks, hickories, yellow birch, sycamore, and aspen were also occasionally used for nesting in the midwest. Barred Owls most frequently nested in cavities in live or dead "large old trees".

Deciduous woodland habitats, specifically riparian and lowland areas, were most frequently chosen (Table 2). "Pure coniferous forest habitats" were not recorded in the midwest, and only infrequently over North America for nesting. Mixed forests were used; unidentified deciduous trees in such forests provided the most frequently used nest sites in the midwest. Throughout North America, so called "virgin forests" and "large trees in mixed woods" provided frequent nesting sites. Few nested in abandoned nests of Red-shouldered Hawks, Red-tailed Hawks, Cooper's Hawks, and Goshawks, especially in areas with young timber.

TABLE 2
Barred Owl Nesting Habitat Preferences

	North America		Midwest	
	Total #	% of Total	Total #	% of Total
DECIDUOUS:				
Unidentified	14	28	4	50
Deep Forests				
Riparian & Lowlands	10	27	2	25
Subtotal:	24	65	6	75
CONIFEROUS:				
Unidentified	3	8		
Subtotal:	3	8	0	0
MIXED WOODLANDS:				
Unidentified Deciduous	3		2	25
Large Tree	1			
"virgin forest"	1			
Unidentified Mixed	5			
Subtotal:	10	27	2	25
TOTALS:	37	100	8	100

Nest Heights

Mean nest heights for Barred Owls (Table 3) approximated 30 ft. (range: 5-100) above ground.

Productivity

Average clutch sizes were the same in the midwest and over North America. Clutch sizes ranged from 1-3 eggs over North America and 1-4 eggs in the midwest with a mean of 2.2 eggs per nest. The number of nestlings averaged two per nest.

Sharp-Shinned Hawk

Nest Tree and Habitat Selection

Fourteen tree species or species groups were used by nesting Sharp-shinned Hawks (Table 4). Coniferous trees were favored over deciduous species (24%) over North America. In the midwest, only conifers were used. Eastern hemlock was most frequently used, followed by red pine, white pine and black spruce. Over North America, hemlock was the most important nest tree followed by pines (white, red, ponderosa) and douglas fir. Oaks (bur, water, and white), maple, poplar and willow, in order of importance, were also used as nest trees.

No deciduous forest habitats were used for nesting in the midwest (Table 5). However, mixed woodlands (55%) and pure stands of conifers (46%) were nearly equally as important habitats throughout North America. Nests in deciduous and coniferous woods were most frequent in "moist ravine forests" and "spruce-fir habitats". Nesting has occurred in northeastern United States red pine plantations.

TABLE 3

Nesting Heights (feet) Clutch Sizes, and Number of Nestlings
in the Midwest and over North America for 7 Raptors of the Ottawa National Forest, MI

Species: Geographical Level	Nesting Heights $x \pm$St.D.	Range	(N)	Clutch Sizes $x \pm$St.D.	Range	(N)	Number of Nestlings $x \pm$St.D.	Range	(N)
Barred Owl:									
Midwest	31.3±22.3	5-100	(26)	2.16±0.84	1-4	(11)	2.0 ±0.65	1-4	(20)
North America	29.6±18.75	5-100	(49)	2.2 ±0.78	1-3	(15)	2.02±0.78	1-3	(55)
Sharp-shinned Hawk:									
Midwest	31.6± 6.1	21.5-40	(35)	4.2 ±1.2	0-5	(11)	2.3 ±2.1	1-4	(4)
North America	30.4±13.7	5-60	(35)	3.9 ±1.3	0-6	(37)	2.7 ±1.5	1-6	(31)
Cooper's Hawk:									
Midwest	45.9±12.4	20-70	(50)	3.2 ±1.0	0-5	(37)	2.4 ±1.3	0-5	(17)
North America	39.1±14.6	15-80	(111)	3.5 ±1.0	0-5	(72)	2.8 ±1.1	0-5	(47)
Goshawk:									
Midwest	45.1±15.9	20-84.3	(23)	2.6 ±1.2	0-4	(14)	2.4 ±0.86	0-4	(21)
North America	38.6±12.8	20-84.3	(67)	2.7 ±0.88	0-4	(44)	2.6 ±0.81	0-4	(50)
Red-shouldered Hawk									
Midwest	42.6±12.1	20-80	(55)	3.2 ±2.4	0-4	(24)	2.8 ±1.4	0-4	(65)
North America	47.0±18.3	18-110	(274)	2.5 ±1.0	0-5	(101)	2.3 ±0.9	0-5	(307)
Merlin:									
Midwest	No Data			No Data			No Data		
North America	17.7±10.2	5-35	(18)	2.5 ±1.4	0-4	(6)	2.84±1.3	0-5	(21)
Northern Harrier:									
Midwest	Not Applicable			3.8 ±1.6	1-7	(78)	3.3 ±1.6	1-6	(65)
North America	Not Applicable			3.7 ±1.7	1-7	(428)	3.3 ±1.4	1-6	(349)

Nest Heights

Midwestern Sharp-shinned nests were slightly higher (32 ft.) in trees than the average height (30 ft.) over North America (Table 3). However, the maximum nesting height was lower in the midwest than over North America. Greater variability in North American nest heights resulted from the generally lower nesting heights of western and Canadian province boreal forest nests and higher nest heights in larger conifers of the Pacific northwest. Nests in conifers were within a few meters of the tree tops, generally appressed to the tree trunk at major limb nodes. Nests in deciduous trees were often located in branch points slightly below the tree top.

Productivity

Midwestern clutch sizes averaged slightly larger (4.2 eggs vs. 3.9) than over North America, while there were slightly more nestlings (2.7 vs. 2.3 birds per nest) over North America than in the midwest. Maximum clutch size over North America was 6 eggs; 5 in the midwest. Maximum number of nestlings was 6 over North America and 4 in midwest states.

TABLE 4

Tree Species and Species Groups
Used by Nesting Sharp-shinned Hawks

	North America		Midwest	
	Total #	% of Total	Total #	% of Total
DECIDUOUS:				
Unidentified	1			
Maple	2			
Poplar	2			
Willow	1			
Bur Oak	1			
Water Oak	1			
White Oak	1			
Subtotal:	9	24	0	0
CONIFEROUS:				
Unidentified	3			
Hemlock	9	24	7	64
Pine	3			
Ponderosa Pine	2			
Spruce	4	11		
Douglas Fir	3			
Black Spruce	1		1	
White Pine	1		1	
Red Pine	2		2	
Subtotal:	28	76	11	100
TOTALS:	37	100	11	100

Cooper's Hawk

Nest Tree and Habitat Selection

Eleven midwestern tree species and species groups were used for nesting (Table 6). Unidentified deciduous species were most frequently used followed by oak, maple and beech. The remaining nests (17%) were located in conifers, with white pine (66%) used most frequently. Jack and red pine, and white cedar were used equally. Over North America, deciduous nest trees were chosen slightly less often than in the midwest, 81% vs. 83%, but were very important. Unidentified deciduous tree species were the most important nest trees followed by oaks, poplars and cottonwoods, maple, sycamore, beech, cherry, ash and elm. White, red and jack pine were the most frequently used midwestern conifers. Spruces were the second most frequently used tree species group over North America.

In the midwest, 73% of all nests were in deciduous forests; most in "deep forest" (Table 7). Mixed woodlands were second in importance followed by coniferous habitats (6%). Similar trends were evident over North America. Deciduous, riparian-woodland habitats assumed more importance over North America for nesting habitat because of the scarcity of trees in western high plains and prairie areas, except along waterways.

TABLE 5

Sharp-shinned Hawk Nesting Habitat Preferences

	North America		Midwest	
	Total #	% of Total	Total #	% of Total
DECIDUOUS:				
Unidentified Forest Edge	1			
Expansive Forests, Deep Forests, Canyon)Ripa-rian	1			
Moist Forests	1			
Subtotal:	3	9	0	0
CONIFEROUS				
Unidentified	7			
Moist Ravine	2			
Pine Plantations				
Spruce Swamp	1			
Spruce-Fir	1			
Subtotal:	13	37	5	46
MIXED WOODLANDS:				
Mixed Woodland	16			
Thick Conifer Grove	2			
Deep Woods	1			
Subtotal:	19	54	6	55
TOTALS:	35	99.9	11	100

Nest Heights

Midwestern Cooper's Hawk nest heights ranged from 20-70 ft. ($\bar{x}$ 46 ft.) (Table 3). In contrast, North American nests averaged 15% lower (range 15-80 ft.). With the exception of records in the Pacific northwest (which were in the tallest trees), most western and southwestern nests were located at heights nearer the lower end of the nesting height range.

Nests were located above mid-tree and generally a few meters below tree top. Nests in conifers were in upper branches and rested against the main trunk. Nests in deciduous trees were on main limb branch points and horizontally forked limbs.

Productivity

Estimates of average clutch sizes (Table 3) were similar throughout; slightly smaller averages were found in the midwest. Maximum clutch size was 5 eggs. Production over North America may be higher than in the midwest. A maximum of 5 nestlings was recorded.

TABLE 6

Tree Species and Species Groups
Used by Nesting Cooper's Hawks

	North America		Midwest	
	Total #	% of Total	Total #	% of Total
DECIDUOUS:				
Unknown	42	35	30	56
Oak	4		1	
Live Oak	3			
Black Oak	4		4	
Red Oak	4		2	
White Oak	2		2	
Cottonwood	3			
Balsam Poplar	6			
Poplar	4			
Aspen	9			
Beech	2		2	
Elm	1			
Hackberry	1			
Ash	1			
Black Cherry	2		1	
Sugar Maple	5		3	
Black Birch	1			
Shagbark Hickory	1			
Sycamore	3			
Subtotal:	98	81	45	83
CONIFEROUS:				
Unknown	3	3		11
White Pine	6		6	
Red Pine	1		1	
Jack Pine	1		1	
White Cedar	1			
Spruce	4			
White Spruce	2			
White Fir	1			
Douglas Fir	1			
Dead Tree	2			
Subtotal:	22	18	9	17
TOTALS	120	100	54	100

Goshawk

Nest Tree and Habitat Selection

Twenty North American tree species and species groups were utilized (Table 8). Eight were used in the midwest. Deciduous trees were used twice as frequently as conifers over North America, and 9 to 1 over conifers in the midwest. Most important deciduous nesting trees were beech followed by maples, aspen and yellow birch. Eastern white pine was the most frequently used North American conifer followed by spruce, fir, western pines and eastern hemlock. Eastern hemlock and red pine were the most important midwestern conifer nest trees.

TABLE 7

Cooper's Hawk Nesting Habitat Preferences

	North America		Midwest	
	Total #	% of Total	Total #	% of Total
DECIDUOUS:				
Unknown	48	56	32	62
Expansive Forests	2			
Deep Forests	4		4	
Disjuncted but Proximal Woodlots	5		1	
Forest Edge Site				
Riparian	5		1	
Subtotal:	67	78	38	73
CONIFEROUS				
Unknown	9	11	3	6
Subtotal:	9	11	3	6
MIXED WOODLANDS:				
Unknown	14		11	21
Riparian	1			
Expansive Forests	1			
Deep Forest				
Forest Edge Site	1			
Subtotal	17	20	11	21
TOTALS:	86	100	52	100

Goshawks preferred mixed woodlands for nesting (Table 9). At both geographic levels, deciduous woodlands were of secondary importance; "pure conifer forests" were least used habitat over North America, and were not used in the midwest. Of the identified deciduous habitats, "thick old growth forests" were used and identified mixed woodland habitats, the so-called "virgin forests" were most frequently used, followed by "deep woods" and "thick conifer groves" in deciduous woods.

Nest Heights

Midwestern Goshawk nests were located an average 6 ft. higher than North America (Table 3) although they were within the same range of heights.

Productivity

Mean clutch sizes and ranges were similar throughout North America, approaching a mean of 3 eggs with a maximum of 4. Two to 3 young per nest were recorded in both the midwest and North America with a maximum of 4.

TABLE 8

Tree Species and Species Groups
Used by Nesting Goshawks

	North America		Midwest	
	Total #	% of Total	Total #	% of Total
DECIDUOUS:				
Unknown	6		2	
Yellow Birch	4		1	
Beech	16	22	10	45
Maple	11	15	4	18
White Birch	2			
Aspen	6		2	
Silver Maple	1			
Poplar	1		1	
Cottonwood	1			
Libocedrus	1			
Subtotal:	49	67	20	91
CONIFEROUS:				
Unknown	2			
White Pine	9	12		
Hemlock	2		1	
Engellman Spruce	2			
Norway Spruce	1			
Ponderosa Pine	2			
Pine	2			
Lodgepole Pine	1			
Douglas Fir	2			
Red Pine	1			
Subtotal:	24	33	2	9
TOTALS:	73	100	22	100

Red-Shouldered Hawk

Nest Tree and Habitat Selection

Red-shouldered Hawk nests were found in 37 different tree species or species groups over North America (Table 10). By far, deciduous trees were more important than conifer and miscellaneous nest trees throughout North America. Most important midwestern deciduous tree species were beech and oaks, followed by maple. White pine was the most important midwestern conifer. However, the high importance of unidentified midwestern trees should not be overlooked. Throughout North America, oaks were the most frequently used followed by beech, unknown deciduous, sycamore, and eucalyptus. Some of the less frequently used upper midwestern species (or species groups) used in other areas of North America include yellow and paper birch, aspen, black cherry, ironwood, elm and ash.

Midwestern hawks did not nest in coniferous woodlands (Table 11) and only 5% of 155 nests reported in North America were in this habitat. Riparian coniferous habitats were the most important of the conifer forests and riparian deciduous forest habitats were important throughout North America. Mixed riparian woodlands were also important over North

TABLE 9

Goshawk Nesting Habitat Preferences

	North America		Midwest	
	Total #	% of Total	Total #	% of Total
DECIDUOUS:				
Unknown	16		7	
Expansive Forests				
Deep Forests	1			
Virgin Forests				
Riparian				
Thick Growth	2			
Old Growth	2			
Large Second Growth	1			
Subtotal:	22	34	7	30
CONIFEROUS:				
Unknown	9			
Spruce Fir	2			
Spruce-Pine	1			
Spruce Swamp				
Hemlock Grove				
White Pine Grove				
Large Second Growth	2			
Subtotal:	14	22	0	0
MIXED WOODLANDS:				
Mixed Woodland	18		11	
Thick Conifer Grove	2		1	
Deep Woods	3			
Virgin Forest	5		4	
Subtotal:	28	44	16	70
TOTALS:	64	100	23	100

America. Red-shouldered Hawks preferred deciduous forests slightly over mixed woodlands in the midwest, whereas over North America, deciduous woodlands were strongly favored over mixed woodlands.

Nest Heights

Midwestern nests were recorded over a narrower range of heights and found at lower levels (43 ft.) than over North America (47 ft.) (Table 3). Nests were located on main limb forks usually near 2/3 the maximum height of the tree.

Productivity

Midwestern clutches were larger than over North America. Nestling production was higher in the midwest but more variable than North America. Maximum number of nestlings was 1 larger over North America.

TABLE 10

Tree Species and Species Groups
Used by Nesting Red-shouldered Hawks

	North America		Midwest	
	Total #	% of Total	Total #	% of Total
DECIDUOUS:				
Unknown	29	12	23	43
Pin Oak	6			
Willow Oak	1			
Red Oak	8		4	
White Oak	9		2	
Oak	22	9	2	
Live Oak	9			
Black Oak	4		1	
Bur Oak	1		1	
Beech	43	18	10	19
White Birch	8			
Yellow Birch	3		1	
River Birch	1			
Cottonwood	1		1	
Poplar	2		1	
Aspen	1		1	
Sweetgum	9			
Hickory	1			
Black Cherry	1			
Sycamore	27	11	1	
Silver Maple	1			
Maple	6		3	6
Mahogany	1			
Tulip Tree	5		1	
Ironwood	1			
Eucalyptus	13	5		
Buttonwood	1			
Willow	1			
Ash	1		1	
Elm	1			
Subtotal:	217	91	52	96
CONIFEROUS:				
Unknown	1		1	
Dwarf Cypress	1			
Austrian Pine	7	3		
White Pine	2		1	
Pine	4			
Loblolly Pine	2			
Hemlock	1			
SUBTOTAL	18	8	2	4
MISCELLANEOUS:				
Royal Palm	3			
Subtotal:	3	1	0	0
TOTALS:	283	100	54	100

TABLE 11

Red-shouldered Hawk Nesting Habitat Preferences

	North America		Midwest	
	Total #	% of Total	Total #	% of Total
DECIDUOUS:				
Unknown	74	48	20	43
Expansive Forests			1	
Deep Forests	1		1	
Riparian	32	21	5	11
Subtotal:	107	69	27	57
CONIFEROUS:				
Unknown	3			
Ravine Moist Forest				
Riparian				
Subtotal:	7	5	0	0
MIXED WOODLANDS:				
Mixed Woodland	30		20	43
Thick Conifer Grove	1			
Riparian	7			
Subtotal:	38	24	20	43
MISCELLANEOUS	3			
Subtotal	3	2	0	0
TOTALS	155	99.9	47	100.4

TABLE 12

Tree Species and Species Groups
Used by Nesting Merlin

	North America		Midwest	
	Total #	% of Total	Total #	% of Total
DECIDUOUS:				
Aspen	5			
Maple	2			
Subtotal:	7	58	0	0
CONIFEROUS:				
Unknown	1			
Spruce	1			
Jack Pine	1			
White Spruce	1			
Scotch Pine	1			
Subtotal:	5	42	0	0
TOTALS:	12	100	0	0

TABLE 13

Merlin Nesting Habitat Preferences

	North America		Midwest	
	Total #	% of Total	Total #	% of Total
DECIDUOUS:				
Unknown	1			
Open Prairie	3			
Aspen Parkland	5			
Associated with Human Habitation	3			
Subtotal:	12	71	0	0
CONIFEROUS:				
Unknown	1			
Spruce-Pine Forest	1			
Riparian	1			
Plantation	1			
Subtotal:	4	24	0	0
MIXED WOODLANDS:				
Mixed Woods	1			
Subtotal	1	6	0	0
TOTALS	17	100	0	0

Merlin

Nest Tree and Habitat Selection

Merlins nested in 7 tree species or species groups throughout North America (Table 12). Deciduous trees were slightly more important than conifers. The most frequently used nest tree was aspen, followed by maple, pine and spruce. Most frequently used habitats were deciduous woodlands, parkland, open prairies, and trees associated with human habitations (Table 13). Coniferous habitats were second in importance and mixed woodlands were the least.

Average height was 18 ft. (range 5-35 ft.) over North America (Table 3). No data were available specific to the midwestern states.

Productivity

A maximum clutch size of 4 eggs, and an average of 2.5 eggs were recorded over North America. Nearly 3 nestlings are produced per nest over North America.

TABLE 14

Marsh Hawk Nesting Habitat Preferences

	North America		Midwest	
	Total #	**% of Total**	**Total #**	**% of Total**
WETLANDS:				
Marsh Meadow:				
Bushes, Brush	8		7	
Mostly Willow & Grasses;	43	6	41	
Sedge, Willow, Milkweed, Aspen, *Solidago*, Canary, Grass, *Spiraea*, Nettle Aster and *Poa*	54	8	54	
Snowbush, Snowberry, Raspberry, Rosebush	11		1	
Sawgrass, Marshgrass	3		1	
Subtotal:	119	17	104	34
Freshwater Marsh:	51	7	19	
Tall Grasses, Reeds and Bullrushes near shore	26	4	5	
Sedge, Leatherleaf, Sphagnum Moss, Rushes and Centrum	36	5	27	
Cattail, Rushes	19		5	
Subtotal:	132	18	56	18
Brackish Water Marsh:	11		0	
Salt Grass, Salicornia Baccharis, Cord Grass				
Bog:	**24**	**3**	**1**	
Tamarack, Spruce Dwarf Birch, Labrador Tea, Jackpine, Sphagnum Moss				
Creek Bank:	2		0	
Dry Pothole, Dry Slough:	12		0	
Cattail, Bullrush				
Swamp:	**3**		**12**	
Tamarack, Birch				
Subtotal:	52	7	13	4

Northern Harrier

Nest Site and Habitat Selection

A minimum of 27 different vegetation associations were used by Harriers. These were divided into 2 general categories: wetlands, with 7 subcategories, and dryland habitats, with 9 subcategories (Table 14). In the midwest, wetland marsh meadows dominated by sedges, willows, grasses and occasional aspen were the most frequently used habitats, followed by

TABLE 14

Marsh Hawk Nesting Habitat Preferences
(continued)

	North America		Midwest	
	Total #	**% of Total**	**Total #**	**% of Total**
DRY LANDS:				
Cultivated Fields: Hay, Alfalfa, Wheat Rye, Fallow Situations, Oats	59	8	7	2
Pasture & Uncultivated Fields: Rosebushes, Grasses, Blackberry	22	3	5	2
Grassland:	102		12	
Western Wheatgrass, Green Needlegrass, Yellow & Sweet Clover	11		2	
Timothy, Alfalfa, Prairie Grasses, Aster, *Poa*, Sand Bluestem, Switchgrass, Nettle & Thistle & *Centrum*	21		14	
Quack Grass	16		16	
Brome Grass	22		4	
Goldenrod	18		18	
Subtotal:	271	38	78	25
Sage/Cold Desert Rangeland:	5		0	
Bushy, Deciduous Brush:	29	4	20	7
Deciduous Woods: Willow, Oak, Dogwood, Pine	13		6	2
Stubble:	7		0	
Buckbrush Rangeland (Prairie):	34	5	0	
Unknown:	59		30	
Subtotal:	147	20	56	18
TOTALS:	721	100	307	100

dryland grasslands, fresh water marshes, deciduous brushy areas, cultivated fields of hay, wheat and fallow fields, deciduous woods, and pasture and uncultivated fields. Most frequently used habitats over North America were marsh meadows and fresh water marshes dominated by rushes, sedges and grasses, followed by dryland grasslands, cultivated fields, buckbrush/rangeland prairies, bushy deciduous growth, boglands dominated by tamarack, spruce, sphagnum moss and pasture and uncultivated fields. Open areas and slightly closed forest areas, both wetlands and drylands, dominated by thick grass growths and graminoid plants, were the most important nesting habitats of the North American Harrier and they used only ground nesting sites.

Productivity

Average clutch sizes approached 4 eggs and ranged from 1-7 eggs (Table 3). Harrier nestling productivities were also similar throughout North America with ranges of 1-6 young per nest and an average of nearly 3 per nest.

Discussion

Even though the problems of non-standardized and subjective terminology were used on card reports, some results are in agreement with our field experiences in the Ottawa National Forest (Apfelbaum, 1979). Preliminary field work, for example, has revealed elm and sugar maple, 2 important Barred Owl nest trees, to agree with card data. Observations concur on the importance of riparian deciduous forest habitats for this species. Field observations of Goshawk nesting habitat support the conclusions of the card program data. We have found nests in maple, aspen, and yellow birch; suggested important nest trees by card records. Similar results were found for the other raptors studied.

Because this study did not include intensive field work, we are unable to compare field and card file data for productivity. However, comparison of card data with literature records is given as an example. A notable discrepancy is in the estimation of Merlin productivity. Cornell data suggested a maximum clutch size of 4 eggs and average of 2.5 eggs per nest for the Eastern Taiga Merlin. However, mean clutch sizes for this same subspecies of Merlin have been measured at 4.5 (N=2), with 2.2 (N=6) nestlings per nest (Fox, 1971; Temple, 1972). Northern and central forest breeders lay 4.5 (N=2) eggs per nest and produce 4 (N=5) nestlings. Cornell records suggested 3 nestlings are produced per nest (N=21). The card records may be more accurate because of the larger sample size. However, this may result from lumping data over all North American populations for which data was available from cards. The literatures and Cornell data base do, however, suggest similar habitat, nest tree species, and nesting heights for this species as well as the others studied.

The Cornell data are in agreement with the clutch sizes for the Red-shouldered Hawk (Henny, 1972). Both studies also suggest midwestern and populations in other areas of the United States have the same general habitat requirements.

Cornell data indicate "larger older growth trees" in "older growth forests" to be important nesting habitats for 6 of the 7 species studies. The Cornell data, by suggesting the importance of American elm to some nesting raptors, hints as to the possible effects of an increased elm mortality on nesting raptors. Dutch elm and phloem necrosis deseases only recently invaded the Ottawa National Forest. Maintenance of older age stands of another suitable nesting tree should be a forest management goal. Potential declines of Barred Owl populations, because of declining elms, may be offset by silvicultural selection for older maple, yellow birch, and possibly aspen. These species also occur in the Ottawa National Forest, and as indicated by the Cornell records, are important nest trees in the midwest.

The data in the Cornell nest record card files have provided us some data necessary for raptor management in the Upper Peninsula of Michigan. It may serve equally valuable for other areas of the country.

Acknowledgments

The authors thank the Ottawa National Forest for supporting non-game animal studies, especially Mr. Robert Stockton of the Ottawa; the Cornell Laboratory of Ornithology for use of the nest card data and Messers Robert and Patrick Dunlavey and Ms. Sally Hetzel and Ms. Judy Ross for their help in this study.

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RAPTOR COLLISIONS WITH UTILITY LINES

A Call for Information

The U.S. Bureau of Land Management, Sacramento, in cooperation with the Pacific Gas and Electric Company, is assembling all available published and unpublished information concerning collisions of raptors with power lines and other utility lines. Actual case histories — no matter how circumstantial or fragmentary — are needed. Please acknowledge that you have such information by writing to Dr. Richard R. (Butch) Olendorff, U.S. Bureau of Land Management, 2800 Cottage Way, Sacramento, California 95825 U.S.A. (Phone (916) 484-4541). A form on which to record your information will then be sent by return mail.

Request for Assistance

Adult and nestling Turkey Vultures in Wisconsin are being marked with green patagial wing tags during 1983 and 1984, as part of a study of nest and roost fidelity, feeding ranges, and migration. Tags are encoded with a small "U" and large white numberals, 1-99. If marked vultures are sighted, please report date, location, tag number, whether tag is on right or left wing, and other pertinent observations to the Bird Banding Laboratory, U.S. Fish and Wildlife Service, Laurel, Maryland 20811, and to Madison Audubon Society, Rt. 1 Box 128A, Arlington, WI 53911.

BALD EAGLE ACTIVITY AT AN ARTIFICIAL NEST STRUCTURE IN ARIZONA

by
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Abstract

Bald Eagle (*Haliaeetus leucocephalus*) nesting activity was recorded with time-lapse photography at an artificial structure in central Arizona during the 1978-79 breeding season. Nest repair was evident more than 4 months before egg laying, with most activity initially concentrated at dawn and dusk. Nesting efforts continued despite flooding and subsequent human manipulation of the nest. Management implications of artificial nests, survey techniques, and post-failure activity are discussed.

Introduction

The Bald Eagle breeding area observed during this study is located along the Verde River in central Arizona. It was discovered in 1975, when an adult pair was present but unproductive (Rubink and Podborny 1976). Two young were fledged in 1976 although during incubation the reservoir level rose to within 2.5 m of the nest, which fell prior to fledging (Duane Rubink, pers. comm.). In 1977, after high winds toppled the nest tree with two viable eggs (Grubb and Rubink 1978), a tripod made of 10.2 cm aluminum irrigation pipe in 14.3 m lengths, bolted at 12.2 m, was erected to provide support for the original nest (Grubb 1980). During the 1977-78 breeding season time-lapse photography showed the eagles occasionally perching and roosting on the structure, but eventually an alternate cliff nest was used. This paper describes the results of time-lapse monitoring of the tripod from mid-October through mid-April during the 1978-79 breeding season. Nesting activity usually lasts from December until June, with egg laying occurring by late January. The objectives of this study were first, to document Bald Eagle use of the artificial nest structure and the emergency modification described below, and second, to determine the pattern of adult presence at the nest during various stages of the breeding cycle.

Methods

On 21 December 1978, a 1.2-m cubical framework made of 5- x 10-cm studs was placed on top of the tripod after the original nest in the apex (Fig. 1) had been inundated by reservoir waters (Fig. 2). Materials from the original nest were used to construct a new nest on an expanded aluminum grid across the top of the framework. By working nest sticks through the grid holes (1.9 x 5 cm diamond pattern) it was possible to firmly anchor the nest without any special form of attachment. Additional perch branches were wired to the scaffolding, and all bare wood was camouflaged with brown spray paint. The original tripod was designed with a 10.7-m apex height and positioned to approximate the 1977 nest tree height and locaton (Grubb 1980).

A Canon Super 8 movie camera (Model 814XL)[1] equipped with an 8X zoom lens was used in conjunction with a Telonics TIC-2[1] intervelometer to take time-lapse films of the tripod nest from a cliff approximately 60 m away. The

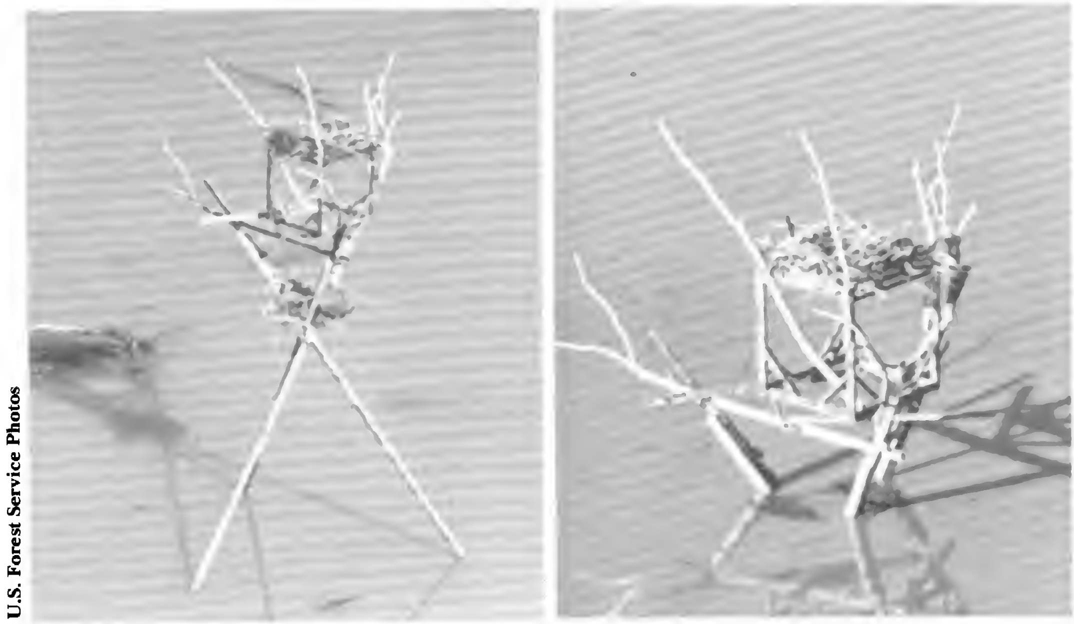

Figure 1. — (A) Partially exposed tripod support structure showing original Bald Eagle nest and raised nest, and (B) a typical water level that occurred through nest repair and incubation (see Fig. 2), necessitating the scaffolding superstructure.

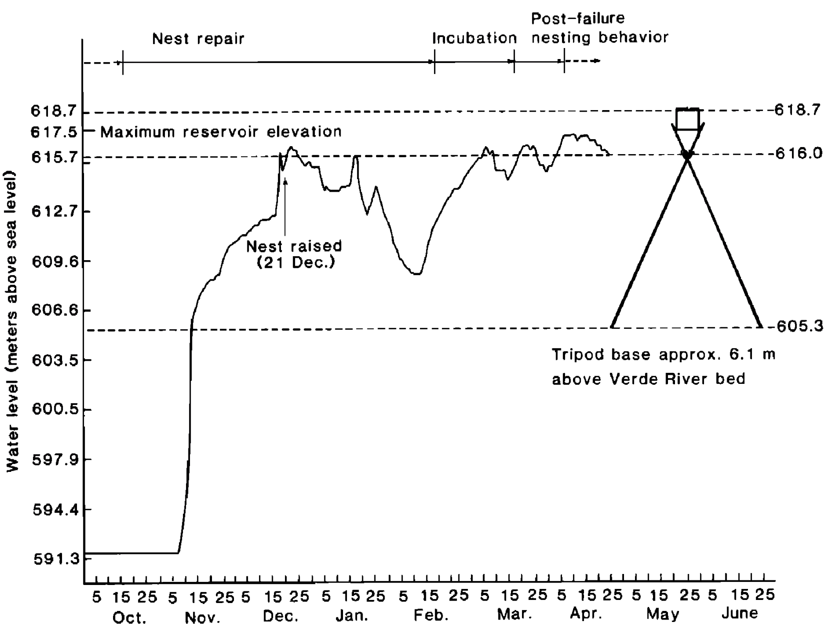

Figure 2. — Horseshoe Reservoir water levels, October 1978 - April 1979, showing the extensive fluctuation that occurred during the Bald Eagles' nesting attempt on the artificial structure.

camera was in the field from 17 October 1978 through 13 April 1979. The film interval was set at 2 frames, 10 seconds apart, every 6 minutes. The second frame of each pair was taken to provide verification of the first frame. On a standard Super 8, 3600-frame (50-foot) cartridge, this provided 15-17 days of daylight coverage. The intervelometer was set to operate only when the camera had enough light to photograph properly. About 1 hour of actual light at dawn and at dusk was lost with the ASA 40 film used. To access the camera with minimal disturbance to the eagles, a low rock blind was built along the cliff face. The author's dog, an Alaskan malemute, was permitted to wander quietly nearby to distract the incubating eagle's attention from the process of changing film.

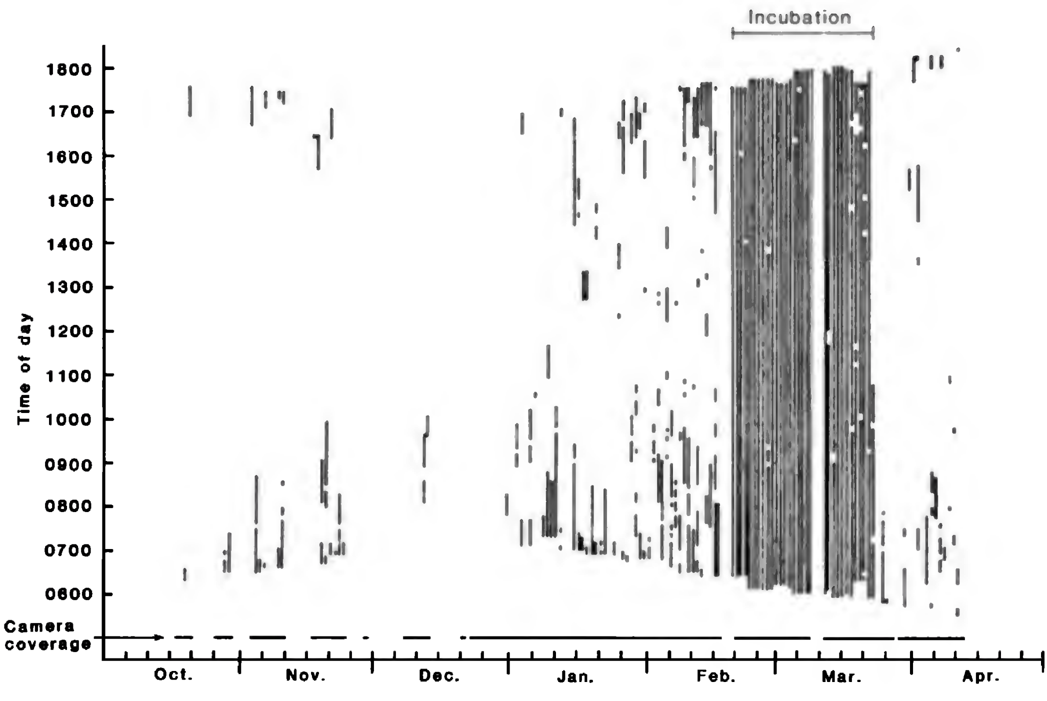

Figure 3. — **Bald Eagle presence at the artificial nest structure shown in Fig. 1, October 1978 - April 1979, as recorded by time-lapse photographic sampling.**

Results

Figure 3 shows the daily time on the nest by one or both adults during the study period. No eagles were observed in the area during the approximately 6 hours required to erect the scaffolding and construct the new nest. Time-lapse films before and after 21 December indicate sporadic (Fig. 3, 4b) but consistent (Fig. 4a) attention to the nest. On 31 December, both adults were recorded at the structure adding and rearranging sticks on the new, upper nest. Although the film coverage in December was incomplete, the eagles apparently accepted

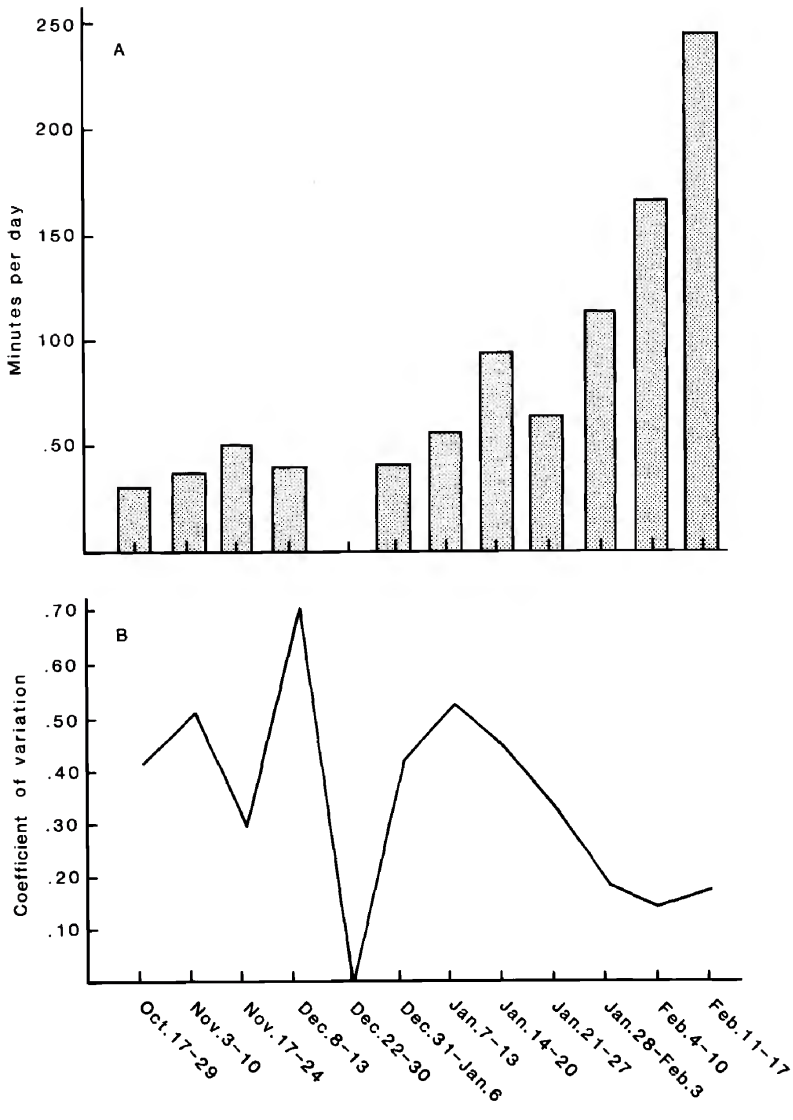

Figure 4. — (A) Average time spent by adult Bald Eagles at the tripod nest during the pre-incubation period, and (B) the coefficient of variation for average times at the nest (minutes/day).

the structure modification and relocated nest with little, if any, disruption of their previously established or subsequently recoreded, intermittent pattern of nest building activity.

Adult presence fluctuated but gradually increased through the nest repair, pre-egg-laying period, with a marked increase just prior to egg deposition (Fig. 4a). The corresponding coefficient of variation on average time-at-the-nest-per-day indicates large initial variation and steady decrease as egg laying was approached (Fig. 4b). Neither adult was recorded on the nest during midday hours until 6 January, more than 2 months after nest building began and about 1½ months before egg laying (Fig. 3). Throughout most of the pre-egg-laying period

the eagles were present only while the tripod was in the shadows of early morning or late afternoon, well before or long after the nest was in direct sun. However, the amount of daytime presence increased as egg laying approached.

In the 2 weeks prior to egg laying, which apparently occurred between 17 and 20 February when full time incubation began, an adult was in the incubating posture on 9 different days for an average of about 35 minutes per day. Table 1 summarizes these observations by date, length of incubating posture activity, and time of day. In a pattern similar to that recorded for adult presence from the onset of nesting, 14 of 15 bouts of incubation posture occurred during morning and evening hours. Only on the last day of record before incubation began was this behavior seen during midday hours.

Table 1. Incubation posture prior to egg laying. (Early morning designates activity during the first hour of photographic sampling, beginning about 1 hour after first light. Morning activity occurred within the second hour of sampling. All evening activity was within the last hour of filming, up to about 1 hour before dark.)

Date	Time in Incubating Posture (nearest 10 min.)	Time of Day
February		
6	30	Early morning*
9	10	Morning
	10	Late evening*
10	20	Early morning*
	20	Morning
11	20	Late evening
12	10	Morning
	30	Late evening
14	20	Late evening*
15	30	Morning
	30	Late evening
16	30	Early morning
	10	Midday
17	30	Early morning*
18-20	720	Full-time incubation

* Incubation posture continued after photographic sampling ceased, or was already in progress when filming began.

No pattern in the simultaneous presence or activity of both adults was apparent through the study period. Both birds were present at the nest (on the nest itself or perched on one of the tripod branches) during approximately 50% of the eagle observations recorded. Both adults also actively repaired the nest following failure. Three occasions of perching by Great Blue Herons (*Ardea herodias*) and an immature Bald Eagle indicate the resident pair was not within sight of the nest during those periods. On 15 site visits between 12 October and 20 February, adults were observed only 5 to 6 times.

Feeding on the nest was noted 7 times. Four occasions were recorded on film during the pre-incubation period — 15 and 18 January, and 12 and 17 February. Both adults were involved on three occasions. On 20 February, the incubating bird was observed to fly from the nest and return with a small prey item, which was consumed at the nest edge. Fresh feathers and avian bones, mostly American Coot (*Fulica americana*), found in the nest on 13 and 16 April evidence at least two additional feedings at the nest following failure.

On 71 oicasions, at least 1 eagle was present during either the first or last frames of the day (48 and 23 respectively). Overnight roosting was suspected only when an eagle was recorded in the same position on a perch during the last footage of the evening and during the first frames of the followng morning. Six such instances were recorded: 31 January; 9, 13, 16, and 17 February; and 5 April. The incubation period when nest attendance was full-time was not considered.

The post-failure pattern of nest attendance was similar to the sporadic nest attendance of early January (Fig. 3). Behavioral similarities were also noted: more sticks were added and the nest bowl was reshaped and relined with herbaceous material, including some fresh green leaves. The nest structure was used occasionally by both adults for perching and feeding; overnight roosting was suspected once. The cause of failures, which occurred by 23 March when incubation ceased, is unknown. Breakage due to thin egg shells is suspected since small, membraneous shell fragments were later found in the nest.

Precipitation (days, amount, and deviation from normal) and eagle presence (frequency and duration) were compared on both a monthly and daily basis. Despite the heavy rains of November, December, and January (more than 10 cm above the 10-year average each month), no related variation in the overall trend of nest attendance or behavior was evident.

Discussion

Several biases are inherent with this time-lapse method of recording data. The inability to record eagle presence during the first and last hours of daylight has already been mentioned. Nest visits less than the 6-minute interval between samples also went unrecorded. In addition, because of technical or logistical difficulties, there were occasional gaps in the time-lapse coverage, especially during the first months of activity. Finally, the time-lapse camera was focused on the nest structure and thus provided no information on the presence of the adults elsewhere in the breeding area.

Freshly added nest materials and castings below the tripod indicated Bald Eagles were frequenting the tripod nest prior to 19 October, when they were first recorded on film. Nest building and using the nest as a feeding station apparently continued beyond mid-April, when camera coverage ended. These observations along with the photographic limitations described above, suggest conservative findings.

Variations in daily and weekly presence (Figs. 3, 4) may be explained by a changing prey base that could sometimes require greater foraging effort to procure. Such patterns could also represent gradual intensification of nesting activity and site attachment as the season progresses. Field and photographic observations suggest that the breeding pair is absent from the nest site much of the time prior to egg laying, and that other species may perch on the occupied nest during the eagles' absence. The first midday presence of eagles at the tripod nest (6 January) coincides with the first records of feeding (15 January) and suspected overnight roosting (31 January) on the nest. Both these activities were recorded several additional times through the beginning of incubation, a period during which midday attendance also increased.

Most survey efforts across the country are conducted during daylight hours for obvious reasons (Grubb et al. 1975, Grier et al, 1981). It follows that most observations are made through the midday period. Conceivably nests considered unoccupied at the usual survey time may have early season activity that would only be evident during dawn and/or dusk checks. Nest repair activity has been observed in other areas during the fall and winter months, well before the onset of nesting (in Arizona, New Mexico, and Washington, pers. observation; in the Great Lake region, Sergej Postupalsky, pers. comm.; and in Saskatchawan, Jon Gerrard, pers. comm.).

The cause of the thin-shelled eggs and subsequent nest failure in 1979 is undetermined. One of the eagles had a few dark feathers behind its eyes and on the back of its head, which suggests immaturity and the possible recruitment of a new member in the pair. Pesticide contamination is a possible (Bogan and Newton 1977) but improbable (Grubb and Rubink 1978) cause of failure, as is an increased thermoregulatory energy expenditure due to the inclement weather (Stalmaster 1981). Heavy rains may also have reduced prey availability by causing poor visibility in murky waters or by driving prey from the area by flooding. A probable consequence of unusually heavy precipitation is shown in Figures 3 and 4 for the week of 22-30 December, when the adults were totally absent after the tripod nest was inundated by high waters.

Adult presence and activity following nest failure indicate residual nesting behavior (Fig. 3). Similarly in 1977, when the nest tree fell after 27 days of incubation, this pair was observed adding sticks and reshaping their alternate cliff nest. Activity diminished within a month, and no eggs were ever laid. In contrast, at two other central Arizona sites that have failed collectively three times in recent years, with infertile or addled eggs, the adults have abruptly ceased attending the nest after up to 10 weeks' incubation, with no further nesting activity noted. These observations lead to the hypothesis that the amount of post-failure nesting activity in Bald Eagles is inversely proportional to the length of time spent in incubation.

Management Implications

Acceptance of the tripod, and the scaffolding modification during nest repair, demonstrate the remarkable adaptability of nesting Bald Eagles. There is thus a potential for managers to provide artificial nests or nesting structures when natural nests are destroyed or suitable trees are lacking. The tripod was originally designed because of this pair's tendency to nest in short-lived, willow (*Salix goodingii*) snags. Dunstan and Borth (1970) and Postupalsky (1978) have had success in replacing fallen nests in trees, while several Arizona nests have also been successfully placed in both trees and cliffs (Grubb *et al.*, 1982). However, artificial manipulation should be employed only when justified by careful consideration of the alternatives.

Even though the early season activity and diurnal patterns of nest attendance require further documentation and verification, alteration of early season survey techniques and management practices may be warranted. The presence of breeding adults more than 4 months before egg laying, if consistent, could lead to managing for a reduction in potentially disturbing activities, especially during dawn and dusk hours, much earlier in the nesting season. Similarly, it maybe necessary to conduct early season nest surveys during the early and late hours of the day. Observation of post-failure activity suggests that if failure occurs after a lengthy incubation or into the nestling period, it is highly unlikely that the birds will renest. Thus, management restrictions could be eased, if necessary; whereas with early nest failure near or shortly after the onset of incubation, site protection and monitoring should be continued.

Acknowledgments

Jon Gerrard, Sergej Postupalsky, and Art Renfro provided helpful reviews of an earlier draft. Journal reviewers contributed significantly to the final manuscript.

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1984 RAPTOR RESEARCH FOUNDATION MEETING

The 1984 annual meeting of the Raptor Research Foundation, Inc., will be held October 25-28 at Virginia Polytechnic Institute and State University, Blacksburg, Virginia. The tentative schedule is:

25 October	Workshops
26-27 October	Paper and poster sessions
27 October	Banquet
28 October	Open

For further information, program suggestions, or space requests, contact:

Dr. Jim Fraser, Department of Fish. & Wildl. Sci., VPI & SU, Blacksburg, VA 24061, Ph: 703-961-6064.

ANDERSEN AWARD

The 2nd annual William C. Andersen Award for the best student paper was presented at the 1983 Raptor Research Foundation meeting in St. Louis, Missouri. The winner was Mr. Jim Duncan of the MacDonald Raptor Research Center, McGill University. Jim's paper was entitled "Mate Selection in Captive Kestrels: I. Siblings vs. Stranger

Students wishing to be considered for the 1984 Andersen Award must indicate their eligibility when submitting abstracts. Eligibility criteria were published in *Raptor Research* 16(1):30-32. Questions regarding the 1984 award should be directed to:

Dr. Robert Kennedy, Director, Raptor Information Center, National Wildlife Federation, 9412 16th Street, NW, Washington, D.C. 20036.

NEST SITE SELECTION OF THE AMERICAN KESTREL (Falco sparverius)

by
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Philadelphia, PA 19103

The purpose of this study is to compare physical characteristics of active American Kestrel (*Falco sparverius*) nests with those of unused (available) woodpecker cavities in order to evaluate Kestrel nesting preferences. The secondary purpose is to compare Kestrel nests in trees with those in buildings.

Study area and methods

Eighteen Kestrel nests (10 in woodpecker cavities and 8 in buildings) were identified in Nittany Valley, Centre County, PA during 1980 and 1981. Nest sites were found by observing Kestrels using cavities and by direct observation of eggs and nestlings. To compare used and unused sites, 70 woodpecker cavities were randomly sampled within 7 Kestrel home ranges. The following were recorded: 1) height of entrance hole (cm), 2) width of entrance hole (cm), 3) orientation of entrance hole (degrees clockwise from north), 4) distance of hole from ground level (m), 5) tree diameter at entrance (cm), 6) tree diameter at breast height, dbh (cm). Statistical comparisons were done using Wilcoxon Rank Sum two-sample test for median differences (p=0.05), unless otherwise stated. Orientation data were transformed into polar coordinates for statistical analysis (Batschelet, E., AIBS Mono. 1, 1965).

Table 1. Physical characteristics of Kestrel nests and a sample of unused cavities (mean and range).

	Nest Hole								Tree			
	Hole Width (cm)		Hole Height (cm)		Orientation (degrees)		Height from Ground (cm)		Diameter at Cavity (cm)		Diameter at Breast Height (cm)	
Building Nests	11.9	(6-23)	10.2	(5.5-15)	288	(95-350)	5.9	(2.4-9.0)	-	-	-	-
Tree Nests	7.9	(7-10.5)	10.9	(7-30	131	(70-330)	7.8	(4.3-14)	36.4	(23-53.5)	74.1	(39.3-114)
Unused cavities	7.6	(4-28)	8.4	(3.5-34)	160	(0-340)	5.8	(1.7-14)	39.5	(19-77)	62.9	(10.5-114.5)

Results

Building and tree nests differed only in orientation (p=0.025). The tree nests tend to face southeast and the building nests, westerly. Kestrels did not appear to be affected by human activity in building nests, since all building sites had human occupants during the nesting season, and Kestrels successfully fledged young from them. The use of artificial nesting sites may be due either to a shortage of available natural sites or to a preference for these sites.

The sampled woodpecker cavities were similar to the Kestrel nests in cavity orientation. Other studies described similar south and east orientation (Inouye, D.W., Condor 78:101-102, 1976). Woodpeckers and Kestrels obtained an advantage in this orientation through protection from northerly storms or increased solar insolation (McComb, W.C., and R.E. Noble, J. Wildl. Manage. 45:284-289).

Kestrel nests differed from unused cavities by having higher cavity entrance and larger tree dbh (p=0.025, paired t-test). Since these two parameters are correlated (higher nests are in larger trees), a similar trend was expected. When cavity entrances smaller than the smallest Kestrel nest hole (7 cm) were removed from the sample, there was no difference in hole size between used and unused cavities.

Conclusions

Optimal cavity nesting strategy predicts selection of higher nests and smaller holes to protect the nest from ground based predators (Preston, F.W. and R.T. Norris, Ecology 28:241-273, 1947). This study demonstrates a selection by Kestrels for higher nests and larger trees from those available, but did not detect selection for hole size. The selection pressures affecting woodpecker cavity orientation have a similar effect on Kestrel nest orientation.

Acknowledgement

I am grateful to my thesis advisor, Dr. Ed Bellis for his advice, to Bob Light for editorial comments and to Lori Sherman and Eric Jones for their encouragement.

COMPARATIVE ECOLOGY AND BEHAVIOUR OF SWAMP HARRIERS CIRCUS APPROXIMANS, SPOTTED HARRIERS C. ASSIMILIS AND OTHER RAPTORS IN AUSTRALIA AND NEW ZEALAND

The Swamp Harrier (*Circus approximans*) and secondarily, 7 other species of avian predator [the Whistling Kite (*Haliastur sphenurus*,) Brown Goshawk (*Accipiter fasciatus*,) Brown Falcon (*Falco berigora*,) Black-shouldered kite (*Elanus notatus*,) Barn Owl (*Tyto alba*,) Southern Boobook (*Ninox novaeseelandiae*) and Little Raven (*Corvus mellori*)] were studied at Werribee in coastal Victoria, Australia, during 1979-80.

All overwintering Swamp Harriers hunted overlapping home ranges, and home ranges of "permanent residents" (366 ha) and males (324 ha) were smaller than those of "temporary residents" (1255 ha) and females (384 ha). "Visiting" Harriers were trapped, individually marked and then not resighted more than twice. Most of the Harriers left Werribee in spring. Adults (290 km) travelled on average much further than juveniles (55 km) and 6 marked Harriers were sighted or retrapped in Tasmania. One-third of the marked birds returned in autumn to hunt their former home ranges. Over-wintering population densities of Swamp Harriers (one per 60 ha), all raptors (one per 34 ha) and all avian predators (one per 16 ha) were recorded.

Seven search and 6 attack techniques were described. Also described for all of the raptor species were potential species separting mechanisms such as: hunting behaviour, habitats hunted, interspecific interactions, temporal activities and diets. Seasonal fluctuations in the population densities of the avian predators were recorded. Only 4 prey species [(the Rabbit (*Oryctolagus cuniculus*,) House Mouse (*Mus musculus*,) Eurasian Coot (*Fulica atra*) and Field Cricket (*Teleogryllus commodus*)] comprised the bulk of the diet of the 7 species of raptor. However, 3 distinct sets of raptor were identified.

The above feeding ecology and behaviour parameters and the morphology of Swamp Harriers in Australia were compared with those of a New Zealand population. There were no clear trends in phenotypic variability or sexual dimorphism between the two populations. Swamp Harriers from New Zealand have undergone considerable ecological release and density compensation. These differences were discussed with reference to theories on island biogeography.

In 1980 a study of communal roosting by Swamp Harriers and field experiments were conducted to test the information centre hypothesis. The results of the baiting experiments were ambiguous. The number of Harriers attending 5 communal roosts peaked in mid-winter. Few (7%) birds followed others from the roosts, but followers were nearly always among the first birds out of the tall, concealing vegetation in the morning. Some Harriers attempted to discourage followers by attacking them. On the hunting grounds the Harriers' dispersal was significantly and positively correlated with that of their major food species: Coots and ducks. The waterfowl population density fluctuated from day to day within census areas and exhibited marked differences between areas. Overall, the results support circumstantially the information centre hypothesis.

Some 25 km south-west of Werribee, 18 pairs of monogynous Swamp Harriers bred at the density of one pair per 67 ha. Nests were on average 525 m apart. Clutch sizes averaged 3.6 eggs and 24 young were fledged from 12 of the 18 nests. Nestling periods of 43 days (males) and 45-46 days (females) were recorded. Asynchronous hatching, fratricide and the evidence for double clutches in the Swamp Harrier were discussed.

During 1980-81 the Spotted Harrier (*Circus assimilis,*) and secondarily, 9 other species of diurnal raptor [the Whistling Kite, Black Kite (*Milvus migrans,*) Brown Goshawk, Peregrine Falcon (*Falco peregrinus,*) Black Falcon (*Falco subniger,*) Brown Falcon, Little Eagle (*Hieraaetus morphnoides,*) Wedge-tailed Eagle (*Aquila audax*) and Australian Kestrel (*Falco cenchroides*)] were studied near Mildura in arid north-western Victoria. In 1980, 19 Spotted Harrier territories were evenly dispersed over the 134 km^2 study area, but the following year only 2 pairs nested there. In 1980 nest sites averaged 2.8 km apart and territories were about 550 ha. Nests took about 2 weeks to build, incubation periods averaged 33 days and nestling periods 38 days (males) and 42 days (females). A mean clutch size of 3.0 eggs and an average fledging success of 2.2 young per successful nest and 1.3 young per nest site were recorded. Similarly, data were collected on the breeding density, clutch size, nestling periods and breeding success of the 9 other raptor species.

The breeding behaviour of the nomadic Spotted Harriers, from territory establishment to the fledging of their young, was described. Evidence was collected in support of the suggestion that the Spotted Harrier was once a ground-nesting bird like other harriers (*Circus* spp) and that it subsequently became a tree-nester.

It was argued that sexual differences in plumage colour of harriers may best be correlated with their predominant mating system, and not with sexual dimorphism or with hunting and nesting in open country as has been proposed. Data on 6 species of harrier were analyzed to test the above thesis and a previous classification of harriers. A theory on harrier mating systems was proposed. It was suggested that harriers are most often polygynous when optimal nesting habitat is in short supply ("resource defence polygyny"), when food is abundant and perhaps unevenly distributed and when the breeding density of harriers is high.

Rabbits were the main food of 8 of the 10 species of raptor breeding near Mildura, both in terms of numbers eaten (40-75%) and biomass consumed (60-92%). The Starling (*Sturnus vulgaris,*) Stubble Quail (*Coturnix novaezelndiae*) and Galah (*Cacatua roseicapilla*) were the next most important prey species. It was estimated that in 4 months the raptor guild consumed about 14% of the immature Rabbits in the study area.

The breeding behaviour, density and success of Brown Falcons at both Mildura and Werribee were described.

The morphometric and diet data from the thesis were incorporated into a review of current hypotheses proposed to explain the degree of sexual dimorphism in raptors and why females of most raptor species are larger than males.

Baker-Gabb, David John. 1982. Comparative ecology and behaviour of Swamp Harriers *Circus approximans*, Spotted Harriers *C. assimilis* and other raptors in Australia and New Zealand. Ph.D. thesis. Monash University, Melbourne, Australia. 286 pp.

GROWTH AND PRODUCTIVITY OF RED-TAILED HAWKS (Buteo jamaicensis) IN SOUTH-CENTRAL KANSAS

Growth and mortality data were collected from 54 nests of Red-tailed Hawks over three nesting seasons. The purpose of the study was to determine how the productivity of Red-tailed Hawks is affected by the type of habitat (cropland, mixed, or pastureland) dominating the habitat within a three-quarter mile radius of the nest. Nestlings were weighed and the length of their tarso-metatarsus (tarsus) measured at intervals of two to eight days. Growth was measured by comparing changes in body weight and tarsal length with age. Asymptote (fledging) values and growth constants were derived by fitting growth curves after the method of Ricklefs and these two measures of growth were compared

statistically. Raw growth data also were compared graphically by inspection. No statistical difference was found in either measure of growth when data were grouped by nesting habitat, year, or size of brood from which young fledged. Visual inspection of graphs of the raw data similarly revealed considerable overlap of measurements with no subgroup departing substantially from any other group. Mortality rates did not differ by year, but were significantly lower in mixed habitats than in cropland and pastureland. Mean size of broods at fledging was significantly larger in 1982 than the preceding two years. Dates of hatching did not differ significantly among years, habitats, or between nests in which one or more young died and nests from which all young fledged. The evidence is used to suggest that Red-tailed Hawks respond to major differences in prey availability according to year (but not by nesting habitat) by adjusting the number of eggs laid. No other reproductive parameter examined, including the growth of the young, is significantly affected by varying levels of prey availability.

Cress, Gary A. 1983. Growth and Productivity of Red-tailed Hawks (*Buteo jamaicensis*) in South-central Kansas. MSc. Thesis, Wichita State University, Department of Biology, 537 Hubbard Hall, Wichita, KS 67208.

MOVEMENTS OF BALD EAGLES ASSOCIATED WITH AUTUMN CONCENTRATIONS IN GLACIER NATIONAL PARK

Movements of Bald Eagles (*Haliaeetus leucocephalus*) associated with autumn concentrations in Glacier National Park were studied during 1979-81. The objectives of the study were to describe movements and habitats used by this group of eagles and to identify a conceptual framework for management of bald eagles and their habitats at the regional level.

Twenty eagles were captured and equipped with radio transmitters at Glacier National Park during autumns 1979 and 1980. Eagles moved south from Glacier through the Flathead and Swan valleys of northwestern Montana. Three eagles remained in these valleys during winter, but most continued south through eastern Idaho. Wintering areas were documented at American Falls Reservoir on the Snake River, Idaho; the Snake River headwaters region of Wyoming, Idaho, and Utah; the Weber River Valley, Utah; the Rush Valley, Utah; the Snake River near Ontario, Oregon; the Carson Valley, Nevada; and the Klamath Basin, Oregon-California. All wintering areas were within the intermountain region. Sightings of additional eagles equipped with colored patagial wing markers at Glacier during autumns 1977-80 fell predominantly (93%) within the intermountain region and were made most frequently in areas used by transmitter-equipped eagles.

In spring, adult eagles followed converging routes from wintering areas to northwestern Montana and continued north along the foothills of the Rocky Mountain through southern Alberta. Near Lesser Slave Lake, Alberta, 2 routes diverged. Some eagles moved north-northeast toward Lake Claire in Wood Buffalo National Park and the east arm of Great Slave Lake, Northwest Territories. Others moved north-northwest toward the west end of Great Slave Lake and Great Bear Lake, N.W.T. Summer ranges were documented at Lake Claire, the Taltson River, N.W.T., Great Slave Lake, and Great Bear Lake.

The most coherent unit for management of bald eagles and their habitats at the regional level appears to be a broad north-south zone, i.e., a flyway. A flyway system that transcends international boundaries seems to offer the greatest potential for long-term conservation of the species.

Young, Leonard Stephen. 1983. Movements of Bald Eagles associated with autumn concentrations in Glacier National Park. M.S. Thesis, University of Montana, Missoula. 102 pp. (Current address: School of Forestry, U. of Montana, Missoula, Mt. 59812)

HAWK MOUNTAIN RESEARCH AWARD

The Hawk Mountain Sanctuary Association is accepting applications for its eighth annual award for raptor research. To apply for the $500 award, students should submit a description of their research program, a curriculum vita, and 2 letters of recommendation by 30 September 1984, to James J. Brett, Curator, Hawk Mountain Sanctuary, Rt. 2, Kempton, Pennsylvania 19529. The Association's Board of Directors will make a final decision late in 1984. Only students enrolled in a degree-granting institution are eligible. Both undergraduate and graduate students are invited to apply. The award will be granted on the basis of a project's potential to improve understanding of raptor biology and its ultimate relevance to conservation of North American raptor populations.

Biology and Management of Bald Eagles and Ospreys. A proceedings of 32 refereed papers (325 pp.) by over 50 international experts on topics including taxonomy, distribution, winter and breeding population dynamics, nesting habitat and nest site selection, nutritional ecology, prey selection, and management of the North American Bald Eagle and the cosmopolitan Osprey. Typeset and bound with soft cover.

To place orders, write to either David M. Bird, Raptor Research Centre, 21,111 Lakeshore Rd., Ste. Anne de Bellevue, Quebec H9X ICO *or* Dr. Gary Duke, Dept. of Vet. Biol., 295K AnSci/Vet. Med. Bldg., Univ. Minnesota, St. Paul, MN 55108. Price per copy: U.S. $15 plus $2.50 handling; Overseas 15$ (U.S.) plus $5 handling; Canada $18 (CDN) plus $3 handling. Send payment with Canadian orders to D.M. Bird and U.S. and overseas orders to the Treasurer, Raptor Research Foundation, Inc. All profits to Raptor Research Foundation, Inc.

BOOK REVIEWS

Eric Hosking's Owls. Eric Hosking with Jim Flegg. 1982. 169 pages, with numerous photographs, many in color. Pelham Books, London, 12.95.

Owls have fascinated Britain's leading photographer of birds for many years. In 1945 he did an earlier book "Birds of the Night" with C.W. Newberry on owls of the British Isles which contained many black and white photographs. This newest addition contains many photographs of owls from England as well as photographs of zoo kept owls in special settings. Also included are many photographs taken by Mr. Hosking during travels to Australia, Africa and elsewhere. The text is extensive and informative. The book contains the best broad coverage photographic illustrations of Old World members of the Order Strigiformes. Some of the species pictured, such as the West African fishing owls (*Scotopelia*), are little known and considered very rare. — Dean Amadon.

Vanishing Eagles. Test by Philip Burton, illustrations by Trevor Boyer. 1982. 140 pages, numberous color plates, maps, and other illustrations. Eagle Star Insurance Co. No price available.

This work provides a more formal vehicle for Mr. Boyer's artwork accomplished on consignment to the Eagle Star Insurance Co. Thirty-three of the world's known eagles are depicted in color illustrations. Some of the species represented are declining, some are more or less stable in numbers, and others, such as the Bald Eagle, perhaps recovering. Some of the paintings are very good and only an occasional illustration appears a bit garish or overly dramatic. Some of the black and white illustrations of habitat are quite charming. Dr. Burton is best known as editor and co-author of a standard reference on the owls of the world. In this work he has provided a full and authentic text. It is recommended to anyone desiring a visually striking introduction to the eagles. The book is available from the Royal Society for the Preservation of Birds who co-sponsored the publication. — Dean Amadon.

Vogelwelt Schleswig - Holsteins Band II - Greifvögel. V. Looft and G. Busche. 1981. Numerous photographs, many in color. Karl Wachholtz Verlag, Neumünster, West Germany. 35 DM. In German.

Translated "The Birds of Schleswig-Holsteins District, Volume II - Raptors", the book contains a great deal of interesting and new information. For example, one photograph depicts two Common Buzzards (*Buteo buteo*) engaged in combat in the snow over a dispute of ownership of nearby carrion. The combat eventually led to the death of one of the participants. Another photograph depicts 4 "brancher" Peregrines adjacent to a buzzard nest used by the adult Peregrines.

Understanding the Goshawk, 1981. R.E. Kenward and I.M. Lindsay (eds.) Proceedings of a conference sponsored by the International Association for Falconry and Conservation of Birds of Prey, 29 September - 1 October 1981, Oxford, United Kingdom. 195 pp. (Available from: Ian Lindsy, Department of Zoology, South Parks Road, OXFORD OX1 3PS, U.K., for 8.00 sterling, postpaid. Make all checks and international money orders payable to: "British Falconers' Club Conference Account.")

The 21 papers in these proceedings are divided into seven sections: systematics, population trends and human impacts, pollution, population dynamics, behavior, predation and management, and veterinary medicine and domestic breeding.

In the section on systematics, Jan Wattel concludes that *Accipiter gentilis* has evolved "from

generalized scavengers and catchers of slow prey, by way of smaller sparrowhawks, to sparrowhawk-like goshawks. . ., and finally to the larger predater" which was the subject of the Oxford conference.

Population trends and human impacts are discussed in four papers concerning western Europe in general, the Netherlands, Britain, and Bavaria. Papers in other sections also give population data from Finland, Sweden, and West Germany. No papers deal specifically with the Goshawk outside of western Europe, though many of the problems and concepts are applicable throughout the species' range.

Generally, western European Goshawk populatons declined in the 1950s and 1960s, mainly due to toxic chemicals used in agriculture. "Prohibition of the most persistent pesticides was followed by a rapid increase in Goshawk numbers in all countries," according to Heribert Kalchreuter of West Germany. This bright outlook is corroborated by Johan Thissen for the Netherlands where suitable habitat has been extended by reforestation, food availability has increased (primarily pigeons), persecution by man has declined, and use of persistent pesticides has been banned.

The Goshawk has recolonized Britain followng complete extirpation earlier in this century. The current population (estimated at 60 pairs) apparently has resulted from escaped falconry birds or birds deliberately released by falconers — not from dispersal from continental Europe. The paper by Mick Marquiss concerning this remarkable recovery is one of the highlights of the conference proceedings.

Use of the Goshawk as a bioindicator of chemical contamination is discussed by Hermann Ellenberg and Jorg Dietrich of West Germany. They present methods for using raptors as bioindicators, a determination of whether bioindication is a useful concept, and a recommendation that chemical analysis of raptor feathers be used more extensively as a non-destructive assay of heavy metal contamination throughout the world. Two Finnish papers look at other environmental factors which affect Goshawk breeding, particularly the importance of food availability. Goshawk feeding behavior is discussed in two papers by Per Wid'en (activity patterns of wild Goshawks) and by Nick Fox (hunting strategies of trained Goshawks).

The next section of "Understanding the Goshawk" consists of several review articles concerning using trained Goshawks for research, trapping techniques, methods of assessing Goshawk predation, and diseases of Goshawks. The last several papers concern using Goshawks as foster parents for young Peregrines and captive breeding of Goshawks (only 8 pages total). A closing list of participants and their addresses should be useful to Goshawk researchers throughout the world.

"Understanding the Goshawk" leaves the reader with the impression that European Goshawks are reproducing well in most countries within their range, but that some local populations require continued monitoring and protection. Also, the species has a large followng of competent researchers who seem very dedicated to ensuring that the status of the Goshawk continues to improve. As an in-depth analysis of the biology and management of an important forest-dwellig raptor, this publication comes highly recommended by this reviewer.

A Note From the President

At the 1982 Annual RRF Meeting in Salt Lake City, much interest was generated for a resolution supporting the important work being done on the California Condor. Because of limited time, the resolution was not developed to its final form but I promised the members that, once completed, we would publish it in our journal for all to see, copy and/or duplicate. The Directors, officers and many other members provided valuable input on several drafts before the below was fine-tuned to the point where our Directors would sign off on it. To all those that provided assistance, you have my sincere appreciation. Without further adieu, the resolution is as follows:

RESOLUTION

RE: California Condor-Scientific Recovery Efforts

WHEREAS, The Raptor Research Foundation Inc., is dedicated to the research and conservation of raptor species;

WHEREAS, the California Condor is an endangered species rapidly declining towards extinction;

WHEREAS, neither existing nor past management techniques, by themselves, have reversed the decline of this species;

WHEREAS, captive propagation is an acceptable management technique which may save the California Condor;

WHEREAS, properly undertaken radiotelemetry studies can provide valuable information on habitat requirements, social behavior and potential adverse environmental factors and possibly assist in the recovery of injured and/or sick individuals;

WHEREAS, The Raptor Research Foundation Inc., has gone on record (statement by then-RRF President Dr. Richard Olendorff at the May 30, 1980 Meeting of the California Fish and Game Commission) in support of the proposal for captive propagation of the California Condor;

THEREFORE, BE IT RESOLVED THAT THE RAPTOR RESEARCH FOUNDATION, INC., reaffirms its support of carefully planned and scientifically-justified captive propagation and radiotelemetry studies of this species.

BE IT FURTHER RESOLVED THAT THE RAPTOR RESEARCH FOUNDATION, INC., commends the Federal and State agencies and non-governmental organizations concerned with the management of the California Condor for their recent collective efforts to assist this species and their progress in reconciling a variety of opinions regarding condor management and urges them to:

(1) Resolve any differences that might remain between or within the various organizations, and;

(2) Continue to move forward as expeditiously as scientifically justifiable to assist the California Condor using the best available scientific techniques.

THE RAPTOR RESEARCH FOUNDATION, INC.

Signed by the following RRF Officers and Members of the Board of Directors:

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